Heinrich Rudolph Hertz (1857–1894)

One hundred years ago in 1888, Heinrich Hertz, a German physicist, announced that he had generated, detected and measured electromagnetic waves, confirming Maxwell's theory that "ether waves", as they were then called, could exist. Hertz has of course been recognised for his work in this field by the adoption of his name as the unit of frequency (abbreviated to Hz).

In this article, F. C. Judd G2BCX asks whether, in view of this accomplishment in 1888, he should also have been honoured by making this year the "wireless centenary year", or will this now be related to the more practical application of wireless transmission and reception, as for instance by G. Marconi, at a later time?

Heinrich Hertz, the eldest of five children of parents Gustav and Elisabeth Hertz, was exceptionally intelligent and as a child excelled in many school subjects, except music; he was tone deaf. On completing his secondary education he decided to become a structural engineer and accordingly served as an apprentice for one year. At the age of twenty he went to a school in Munich to learn engineering, but his interest soon changed and he took up the study of natural science, mathematics and magnetism. In 1878 Hertz became a student under Helmholtz and Kirchhoff at the Berlin Academy of Science.

In 1879 a prize was offered by the Academy for research on the establishment of a relationship between electromagnetic forces and the dielectric polarisation of insulators. Hertz was encouraged by Helmholtz to take up the work with a view to winning this prize. The problem was however complicated by the fact that electrical oscillations at a sufficiently high frequency could not be generated.

To Hertz this was a challenge; a problem to be overcome and in his own words:

"I reflected on the problem, but abandoned it for the time. In 1886 I took it up again and by using apparatus that was available I produced electric waves and found that by the use of parallel conductors I could determine the presence, or absence of these waves, in the form of nodes or loops, by means of tiny sparks across various positions on these parallel rods. In the same year Sir Oliver Lodge found the same effects while investigating the operation of the lightning conductor. This work of mine was in 1886/7 and was described in a paper *On Very Rapid Electric Oscillations*".

In 1885 Hertz had become professor of experimental physics at the Karlsruhe Technical High School and in 1888 received his Doctorate and was



Heinrich Hertz (Courtesy GEC-Marconi Ltd)

appointed assistant to Helmholtz. Determined to prove that electromagnetic waves could be made to exist in space, he constructed apparatus which consisted of two flat metal plates each connected to a short metal rod terminated with a metal sphere. These were arranged as shown in Fig. 1(a) with the spheres nearly touching, each plate and rod being connected to one of the outputs of an induction coil. This assembly formed what was in effect a "dipole" antenna, but which was at the time regarded as a "capacitor" which could be charged up by means of the induction coil.

When the potential across the "capacitor" reached a critical level it discharged itself via the two spheres (the spark gap) resulting in a sudden disruption of the electric field, this in turn, creating a magnetic flux in space. The persistence of the flux also produced an electric current in the reverse direction thus initiating an oscillatory process. Provided the oscillation was started suddenly, most of the energy thus generated was radiated by the "Hertzian dipole" as a damped wave.

Provided current in the induction coil primary was interrupted at short regular intervals, a series of damped waves could be produced and radiated almost continuously. The induction coil and d.c. interrupter became the "transmitter". For reception and detection of the electric waves at a distance, albeit a short one, a resonator consisting of a circle of metal with a gap terminated by two metal spheres was used. This is illustrated in Fig. 1(b). Radiation from the transmitter was "detected" visually by the appearance of very small sparks across the gap between the spheres. With other apparatus, though similar to that described, Hertz succeeded in generating electromagnetic waves with wavelengths from a few metres to 30 centimetres—ultra short waves!

Some years before the experiments by Hertz, a Professor Thomson had discovered, quite by accident, during a lecture in Philadelphia, that small sparks were being produced at a distance from an energised induction coil he was using for a demonstration. This discovery was not widely publicised and Thomson did not investigate further. Neither did he connect the phenomenon with the Maxwell theory. Why then is Hertz and not Thomson (and others) credited with the discovery and production of electromagnetic waves? Thomson's discovery was accidental as the result of a demonstration for a specific purpose. Others did not take their work to a final stage, i.e., to produce a radiated electromagnetic wave and detect its presence at a distance. Hertz on the other hand carried out a series of experiments directly based on the Maxwell theory that radiation in this form was possible. Not only did he succeed in generating these waves, but also proved that

they behaved in a similar manner to light waves, i.e., they could be reflected and refracted, and travelled at the same velocity as light.

Hertz said of his work: "Such researches as I have made upon this subject form but a link in a long chain. Lack of time compels me, against my will, to pass by the researches made by other investigators; so that I am not able to show you in how many ways the path was prepared for my experiment and how near several investigators came in performing these experiments themselves."

In an electrical journal, Hertz described how he radiated electromagnetic waves. Whilst on holiday in the Alps a young man happened to read the article which for him created a fascinating idea. Why not use the Hertzian waves for signalling? Guglielmo Marconi terminated his holiday and returned to his home in Italy to bring this fascinating idea to fruition!

The Hertz experiments with electromagnetic waves were published in 1888 in a paper entitled *Electromagnetic Waves in Air and Their Reflection.* He summarised the paper by saying: "The hope of these experiments was to test the fundamental hypotheses of the Faraday-Maxwell theory and the result of the experiments is to confirm the fundamental hypotheses of the theory."

During the summer of 1892, Hertz suffered an illness, originally caused by a decayed tooth but which developed into chronic blood poisoning from which he died on New Year's Day in 1894, a few weeks before his 37th birthday.

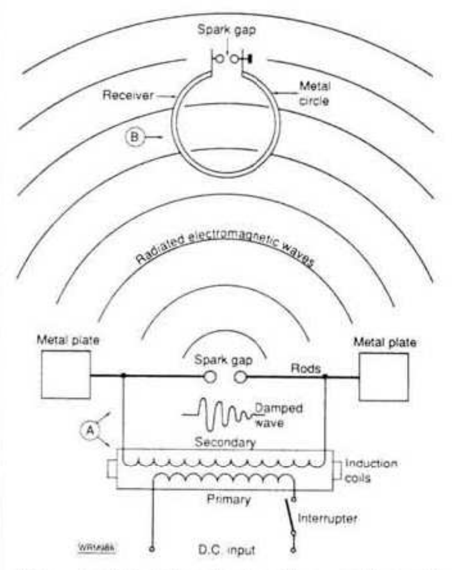


Fig. 1: (a) The induction coil and capacity radiator used by Hertz to generate electromagnetic waves. (The "transmitter" and Hertzian dipole).
(b) The ring resonator "receiver" used for the detection of electromagnetic waves at a distance from the "transmitter"

One of the best tributes to Heinrich Hertz was expressed by Professor Herman Ebert on 7 March 1894: "In him there passed away not only a man of great learning but also a noble man, who had the singular good fortune to find many admirers but none to hate or envy him. Those who came into personal contact with him were struck by his modesty and charmed by his amiability. He was a true friend to his friends, a respected teacher to his students, who had begun to gather round him in somewhat large numbers, some of them coming from great distances; and to his family he was a loving husband and father".

Was this great scientist also the "Father of Wireless"? ***PW***

Notes:

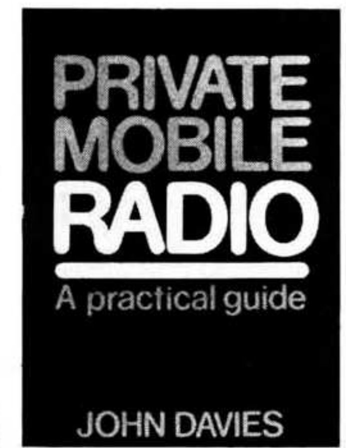
1. Earlier this year The Microwave Theory and Techniques Society of the American IEEE ran a Hertz Centennial Celebration in New York.
2. Thanks are due to GEC-Marconi Limited (Publicity Dept) for information concerned with the life and work of Heinrich Hertz, the photograph and details of the apparatus used by him for the experiment in 1888.

References:

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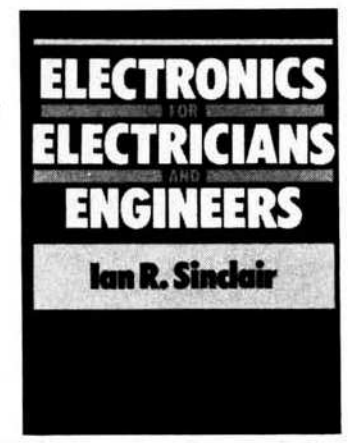


This book was written for people like industrial managers and engineers, surveyors and communications officers of public industries, indeed anyone faced with having to establish a private mobile radio scheme.

The first chapters deal with those principles of telecommunications which the author feels are the minimum essential background information needed. Because the people reading the book are likely to have other duties than radio and cannot afford the time to study too deeply, the writing has been kept as practical and "non-theoretical" as possible.

Later chapters deal with the practical aspects of establishing a scheme. This includes information of the types and performance of the components of a system, the available facilities and the alternatives to a private scheme.

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The rapidly changing technology of electronics has left many technicians requiring an updating of their skills. The same problems have faced other engineers, who now require a knowledge of electronics to understand new developments in their own subjects.

This book has been written for those sorts of people. The aim is to explain principles and devices in clear terms, without assuming a high level of prior knowledge. The early chapters are concerned with a revision of modern electrical principles. In the chapters that deal with electronics, the emphasis has been on principles and devices, but sufficient circuit diagrams have been included to illustrate how the various electronic components are used.

Chapters include such subjects as: Fundamentals, d.c. circuits, a.c. circuits, ions, diodes, transistors and i.c.s.